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(54) REPARAMETRIZED BULL'S EYE PLOTS

REPARAMETERISIERTE BULL'S EYE PLOTS

REPRÉSENTATIONS VISUALISÉES REPARAMÉTRÉES EN POINT DE MIRE

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- **TADANORI FUKAMI ET AL: "Quantitative evaluation of myocardial function by a volume-normalized map generated from relative blood flow; Quantitative evaluation of myocardial function by a volume-normalized map" PHYSICS IN MEDICINE AND BIOLOGY, TAYLOR AND FRANCIS LTD. LONDON, GB, vol. 52, no. 14, 21 July 2007 (2007-07-21) , pages 4311-4330, XP020112977 ISSN: 0031-9155**

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Description

FIELD OF THE INVENTION:

[0001] The invention relates to the visualization of quantitative analysis results in a bull's eye plot, in particular to the visualization of quantitative cardiac analysis results.

BACKGROUND OF THE INVENTION

[0002] Cardiac imaging can be used to determine local myocardial function, perfusion and viability. Nowadays, such images can be obtained using various modalities such as magnetic resonance imaging (MRI), computed tomography (CT), ultrasound (US) and nuclear medicine (PET/SPECT). The images for function, perfusion and viability may be obtained using one modality (MRI) or using hybrid imaging, for instance PET/CT.

[0003] After acquisition, the images are analyzed independently, resulting in a number of measurements performed at different positions at the myocardium. The functional images are used to quantify wall motion abnormalities, the perfusion images are used to quantify perfusion deficits and the viability images are used to quantify scarring of the myocardium.

[0004] These measurements produce quantitative data that are usually displayed in so-called bull's eye plots, in which measurement values are color coded and projected on a plane perpendicular to the long axis.

[0005] Current cardiac analysis software packages generate bull's eye plots in which each ring in the bull's eye plot corresponds to a particular slice in the stack of acquired images. If a comprehensive cardiac exam is performed, bull's eye plots are made based on the (local) measurements derived from each scan. These bull's eye plots are then included in a comprehensive report. Functional measurements that can be displayed in a bull's eye plot are: end diastolic wall thickness, end systolic wall thickness, wall thickening (both absolute and relative), wall motion, time of maximum contraction, maximum wall thickness etc. Perfusion related measurements that can be displayed in a bull's eye plot include time of peak intensity, time of maximum upslope, upslope ratio rest/stress, etc. Viability related measurements that can be displayed in a bull's eye plot are: percentage of viable tissue, thickness of viable tissue, a transmurality index, etc.

[0006] Unfortunately, current scanning procedures do not yet allow acquiring functional, perfusion and viability images of the same resolution. Consequently, the acquired image stacks differ with respect to the slice thickness, slice spacing and the number of slices. Therefore, the derived bull's eye plots consist of arbitrarily distributed different numbers of rings, such that it becomes difficult to compare the complementary information comprised in function, perfusion and viability bull's eye plots. This is illustrated in Fig. 1A showing bull's eye plots derived from a comprehensive cardiac MR exam comprising functional image data containing 10-15 contiguous slices of thickness 8 mm (a), from perfusion images of 3 slices of thickness 20 mm and gaps of 10 mm (b), and viability images of 15-20 slices of thickness 6 mm (c). The bull's eye plots in Fig. 1A are scaled such that they are of substantially the same size.

[0007] A standardized myocardial segmentation for tomographic imaging of the heart has been proposed by the American Heart Association (AHA). The AHA proposal is described in AHA Scientific Statement: Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart, Circulation 2002; 105:539-542 (available online at http://circ.ahajournals.org/cgi/content/short/105/4/539). Fig. 1B schematically shows left ventricular bull's eye plot sectors (a) and the corresponding myocardial slices and sectors (b) according to the AHA model. AHA recommends dividing the left ventricle into equal thirds perpendicular to the long axis of the heart to generate three slices of the left ventricle: the circular basal slice 1 comprising sectors 1 to 6, the mid-cavity slice 2 comprising sectors 7 to 12, and the apical short axis slice 3 comprising sectors 12 to 16. The last sector, the apex 17, is shown in a vertical long axis slice 4. The slice thickness should be selected on the basis of modality-specific resolution and clinical relevance and should be less than 1 cm. While the AHA segmentation allows comparing different cardiac study quantitative analyses, the proposed visualization often ignores large chunks of data which are not comprised in said three slices.

[0008] US 2005/0008209 A1 discloses a system comprising the features of the preamble of claim 1.

SUMMARY OF THE INVENTION

[0009] It would be advantageous to have a system which improves visualizing results of a quantitative analysis of a structure comprised in first image data in a first bull's eye plot, which first bull's eye plot can easily be compared to a second bull's eye plot visualizing results of a quantitative analysis of the same structure described in second image data.

[0010] The invention is defined by the independent claims. Advantageous embodiments are defined in the dependent claims.

[0011] In the system according to the invention, the radius may be, e.g., the external or the internal radius of the ring. The dependence of the first bull's eye plot concentric ring radius on the position of the data slice associated with said concentric ring of the first bull's eye plot, with respect to the object, defines an objective framework for the first bull's eye plot, based on the geometry of the object. Thus, the results of the first quantitative analysis of the object visualized in the first bull's eye plot can be more easily compared with results of a second quantitative analysis of the same object represented in second image data visualized in a second bull's eye plot when the length of the radiuses of the concentric rings of the second bull's eye plot are also defined on the basis of the positions of the data slices associated with said concentric rings of a second first bull's eye plot, with respect to the object. This is because the length of the radius of a concentric ring associated with a slice of the first plurality of data slices, said slice being at a certain position with respect to the object, will be similar to the length of the radius of a concentric ring associated with a slice of the second plurality of data slices, said slice being at a similar position with respect to the object.

[0012] In an embodiment of the system, the data slice associated with the concentric ring comprises a data sector, the slice unit further comprises a slice-sector unit for associating the data sector of the data slice with a ring sector of the concentric ring, the value unit comprises a sector-value unit for computing at least one value for displaying in the ring sector of the concentric ring, on the basis of the data sector associated with the ring sector of the concentric ring, and the position of the ring sector with respect to the concentric ring is defined on the basis of the position of the data sector associated with the ring sector, with respect to the object. By choosing smaller sectors, it is possible to increase the resolution of the first bull's eye plot. Because the position of each sector is based on the position of the corresponding data sector with respect to the object, the objective framework for the first bull's eye plot is based on a more detailed geometry of the object.

[0013] In an embodiment of the system, the first bull's eye plot comprises a concentric ring gap corresponding to an inter-slice gap. This may be necessary if the first image data is sparse and comprises, for example, gaps between data slices of the first plurality of data slices. The ring gaps correspond to the gaps between data slices.

[0014] In an embodiment, the system further comprises an approximation unit for computing at least one value for displaying in the concentric ring gap of the first bull's eye plot on the basis of data slices of the first plurality of data slices associated with concentric rings adjacent to the ring gap. For example, the system can be adapted to interpolate missing data slices of the first image data. The values in the ring gaps can be computed based on the interpolated data slices.

[0015] In an embodiment of the system, the at least one value for displaying in the concentric ring gap of the first bull's eye plot is computed on the basis of values for displaying in the concentric rings adjacent to the ring gap, which values are computed on the basis of data slices of the first plurality of data slices, associated with the concentric rings adjacent to the gap. Using, for example, radial (1-dimensional) or polar (2-dimensional) interpolation of the bull's eye plot values, the system may be adapted for computing values for displaying in the ring gap.

[0016] In an embodiment of the system, the length of the radius of the concentric ring of the first bull's eye plot is computed on the basis of a distance between the data slice of the first plurality of data slices, associated with the concentric ring, and a certain feature of the object. The distance may be defined as the distance between the upper surface of the slice and a point-feature of the object.

[0017] In an embodiment of the system, the width of the concentric ring of the first bull's eye plot is computed on the basis of the thickness of the data slice of the first plurality of data slices.

[0018] In an embodiment of the system, the first bull's eye plot is substantially smooth, i.e., there are substantially no ring edges corresponding to slice boundaries visible in the bull's eye plot. This may be achieved, for example, when the first plurality of data slices comprises a large number of thin data slices, or using interpolation.

[0019] The system is further adapted for visualizing, in a second bull's eye plot, results of a second quantitative analysis of second image data, the second image data comprising a second plurality of data slices. Herein,

- the slice unit is adapted for associating a data slice of the second plurality of data slices with a concentric ring of the second bull's eye plot;
- the radius unit is adapted for computing the length of a radius of the concentric ring of the second bull's eye plot; and
- the value unit is adapted for computing at least one value for displaying in the concentric ring of the second bull's eye plot on the basis of the data slice associated with the concentric ring of the second bull's eye plot;

and the length of the radius of the concentric ring of the second bull's eye plot is defined on the basis of the position of the data slice, of the second plurality of data slices, associated with the concentric ring of the second bull's eye plot, with respect to the object.

[0020] For example, the first and second bull's eye plot showing, respectively, functional and perfusion analysis results may be displayed next to each other for an easy visual inspection by a physician.

[0021] In an embodiment of the system, the lengths of the radiuses of the concentric ring of the first bull's eye plot and of the concentric ring of the second bull's eye plot are computed on the basis of distances from, respectively, the data slice of the first plurality of data slices and the data slice of the second plurality of data slices to a certain feature of the object.

[0022] The system further comprises:

- an indicator input unit for receiving a user input for indicating a first location in the first bull's eye plot, using a first indicator, and a second location in the second bull's eye plot, using a second indicator; and
- an indicator unit for indicating the first location in the first bull's eye plot, using the first indicator, and the second location in the second bull's eye plot, using

the second indicator, based on the user input;

wherein the first and second locations are the same relative to the respective first and second bull's eye plots.

[0023] Thus, the indicated first and second locations correspond to substantially identical locations in the first and second image data. The first and second bull's eye plots are displayed on a display. The indicators help the user compare the results of the first and second quantitative analysis.

[0024] In an embodiment, the system further comprises a slice determination unit for determining a first ring comprising the first location, based on a first data slice associated with the first ring and for determining a second ring comprising the second location, based on a second data slice associated with the second ring. Thus, a comparison of the first and second ring is possible. Optionally, the corresponding first and second data slice may be also displayed next to the corresponding bull's eye plots.

[0025] In an embodiment of the system, the user input for indicating the first location in the first bull's eye plot comprises a certain location in a certain data slice of the first plurality of data slices. In this embodiment, the user may navigate through the first plurality of data slices. The system is adapted for displaying the slices selected by the user for viewing. The user may view the displayed slices, and select a certain location in a certain slice. This certain location is indicated by the indicator unit in the first bull's eye plot, in the ring associated with the certain slice, using the first indicator.

[0026] In a further aspect of the invention, the system is comprised in an image acquisition apparatus.

[0027] In a further aspect of the invention, the system is comprised in a workstation. In a further aspect, the invention provides a method of visualizing as defined in claim 13, and a computer program product as defined in claim 14.

[0028] A person skilled in the art will appreciate that the method may be applied to multidimensional image data, e.g., to 3-dimensional or 4-dimensional images, acquired by various acquisition modalities such as, but not limited to, standard X-ray Imaging, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound (US), Positron Emission Tomography (PET), Single Photon Emission Computed Tomography (SPECT), and Nuclear Medicine (NM).

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] These and other aspects of the invention will become apparent from and will be elucidated with respect to the implementations and embodiments described hereinafter and with reference to the accompanying drawings, wherein:

Fig. 1A shows exemplary prior art bull's eye plots for a function, perfusion and viability scan;

Fig. 1B schematically shows left ventricular bull's eye plot sectors and the corresponding myocardial slices and sectors according to the AHA model;

Fig. 2 schematically shows a block diagram of an exemplary embodiment of the system;

Fig. 3 shows exemplary bull's eye plots based on a function, perfusion and viability scan;

Fig. 4 shows exemplary bull's eye plots, each plot showing an indicated location, and exemplary images computed from data slices associated with rings comprising the indicated locations;

Fig. 5 shows exemplary bull's eye plots, each plot showing an indicated ring, and exemplary images computed from data slices associated with the indicated rings;

Fig. 6 schematically shows an exemplary embodiment of the reporting system;

Fig. 7 shows a flowchart of an exemplary implementation of the method;

Fig. 8 schematically shows an exemplary embodiment of the image acquisition apparatus; and

Fig. 9 schematically shows an exemplary embodiment of the workstation.

Identical reference numerals are used to denote similar parts throughout the Figures.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] Fig. 2 schematically shows a block diagram of an exemplary embodiment of the system 200 for visualizing, in a first bull's eye plot, results of a first quantitative analysis of an object represented in first image data, the first image data comprising a first plurality of data slices, the system 200 comprising:

- a slice unit 210 for associating a data slice of the first plurality of data slices with a concentric ring of the first bull's eye plot;
- a radius unit 215 for computing the length of a radius of the concentric ring of the first bull's eye plot; and
- a value unit 220 for computing at least one value for displaying in the concentric ring of the first bull's eye plot, on the basis of the data slice associated with the concentric ring of the first bull's eye plot;

and wherein the length of a radius of the concentric ring of the first bull's eye plot is defined on the basis of the position of the data slice, of the first plurality of data slices, associated with the concentric ring of the first bull's eye plot, with respect to the object.

[0031] In the exemplary embodiment of the system 200,

- the slice unit 210 further comprises a slice-sector unit 212 for associating the data sector of the data slice with a ring sector of the concentric ring; and
- the value unit 220 comprises a sector-value unit 222 for computing at least one value for displaying in the ring sector of the concentric ring, on the basis of the

data sector associated with the ring sector of the concentric ring;

and the position of the ring sector with respect to the concentric ring is defined on the basis of the position of the data sector associated with the ring sector, with respect to the object.

[0032] The exemplary embodiment of the system 200 further comprises the following units:

- an approximation unit 230 for computing at least one value for displaying in a concentric ring gap of the first bull's eye plot on the basis of data slices of the first plurality of data slices associated with concentric rings adjacent to the ring gap;
  a slice determination unit 240 for determining a first ring comprising the first location, based on a first data slice associated with the first ring and for determining a second ring comprising the second location, based on a second data slice associated with the second ring;
- a control unit 260 for controlling the workflow in the system 200;
- a user interface 265 for communicating with a user of the system 200; and
- a memory unit 270 for storing data.

[0033] In an embodiment of the system 200, there are three input connectors 281, 282 and 283 for the incoming data. The first input connector 281 is arranged to receive data coming in from a data storage means such as, but not limited to, a hard disk, a magnetic tape, a flash memory, or an optical disk. The second input connector 282 is arranged to receive data coming in from a user input device such as, but not limited to, a mouse or a touch screen. The third input connector 283 is arranged to receive data coming in from a user input device such as a keyboard. The input connectors 281, 282 and 283 are connected to an input control unit 280.

[0034] In an embodiment of the system 200, there are two output connectors 291 and 292 for the outgoing data. The first output connector 291 is arranged to output the data to a data storage means such as a hard disk, a magnetic tape, a flash memory, or an optical disk. The second output connector 292 is arranged to output the data to a display device. The output connectors 291 and 292 receive the respective data via an output control unit 290.

[0035] A person skilled in the art will understand that there are many ways to connect input devices to the input connectors 281, 282 and 283 and the output devices to the output connectors 291 and 292 of the system 200. These ways comprise, but are not limited to, a wired and a wireless connection, a digital network such as, but not limited to, a Local Area Network (LAN) and a Wide Area Network (WAN), the Internet, a digital telephone network, and an analog telephone network.

[0036] In an embodiment of the system 200, the system 200 comprises a memory unit 270. The system 200 is arranged to receive input data from external devices via any of the input connectors 281, 282, and 283 and to store the received input data in the memory unit 270. Loading the input data into the memory unit 270 allows quick access to relevant data portions by the units of the system 200. The input data may comprise, for example, the first image data. Optionally, the input data may further comprise a definition of data sectors, of the bull's eye plot ring sectors and of the correspondence between said bull's eye plot ring sectors and the structure sectors. The memory unit 270 may be implemented by devices such as, but not limited to, a Random Access Memory (RAM) chip, a Read Only Memory (ROM) chip, and/or a hard disk drive and a hard disk. The memory unit 270 may be further arranged to store the output data. The output data may comprise, for example, the computed first bull's eye plot data. The memory unit 270 may be also arranged to receive data from and/or deliver data to the units of the system 200 comprising the slice unit 210 further comprising the slice-sector unit 212, the radius unit 215, the value unit 220 further comprising the sector-value unit 222, the approximation unit 230, the slice determination unit 240, the control unit 260, and the user interface 265, via a memory bus 275. The memory unit 270 is further arranged to make the output data available to external devices via any of the output connectors 291 and 292. Storing data from the units of the system 200 in the memory unit 270 may advantageously improve performance of the units of the system 200 as well as the rate of transfer of the output data from the units of the system 200 to external devices.

[0037] Alternatively, the system 200 may comprise no memory unit 270 and no memory bus 275. The input data used by the system 200 may be supplied by at least one external device, such as an external memory or a processor, connected to the units of the system 200. Similarly, the output data produced by the system 200 may be supplied to at least one external device, such as an external memory or a processor, connected to the units of the system 200. The units of the system 200 may be arranged to receive the data from each other via internal connections or via a data bus.

[0038] In an embodiment of the system 200, the system 200 comprises a control unit 260 for controlling the workflow in the system 200. The control unit may be arranged to receive control data from and provide control data to the units of the system 200. For example, after associating a data slice with a concentric ring, the slice unit 210 may be arranged to provide control data "the data slice is associated with the concentric ring" to the control unit 260 and the control unit 260 may be arranged to provide control data "calculate the radius of the concentric ring" to the radius unit 215 and "calculate the values for displaying in the concentric ring" to the value unit 220. Alternatively, a control function may be implemented in another unit of the system 200.

[0039] In an embodiment of the system 200, the system 200 comprises a user interface 265 for communicating with the user of the system 200. The user interface may be arranged to display bull's eye plots. Further, the user interface 265 may be arranged to receive a user input for defining ring sectors and/or for indicating locations in the bull's eye plots. A person skilled in the art will understand that more functions may be advantageously implemented in the user interface 265 of the system 200.

[0040] The embodiments of the invention are described with reference to cardiac bull's eye plots, where the object is the left ventricle of the human heart. Those skilled in the art will understand, however, that the described application should not be construed as limiting the scope of the claims and that other applications are also conceivable.

[0041] In an embodiment of the system 200, the values computed by the value unit 220 are visualized using color coding. The center of the concentric rings of the bull's eye plot corresponds to the long axis of the left ventricle. The length of the external radius of each ring of the bull's eye plot is proportional to the distance from the apex of the left ventricle to the top planar surface of the data slice associated with the concentric ring by the slice unit 210.

[0042] In an embodiment of the system 200, the bull's eye plots are computed at high resolution and appear smooth in the sense that they do not show ring borders. This can be achieved in several ways. For example, the rings of the bull's eye plot may be thin and densely distributed on the plane of the bull's eye plot. This is possible if the image data set comprises a large number of substantially adjacent data slices. Each ring may be further divided into densely distributed small sectors. The widths of the rings and the sizes of the sectors are such that the human eye does not see borders between the sectors. For example, the sector size may be smaller than the size of a display pixel and thus the image granularity is determined by the display resolution. Alternatively or additionally, the approximation unit 230 may be employed for computing approximate values on the basis of the values computed in the rings or ring sectors of the bull's eye plot. Depending on the approximation method, the bull's eye plots may appear as low-resolution plots (e.g. when the number of rings and/or sectors is small, so that the rings or sectors scarcely cover the bull's eye plot and a step-function interpolation is employed) or as high-resolution smooth plots (e.g. when the third-degree polynomial interpolation is employed).

[0043] Fig. 3 shows exemplary bull's eye plots, obtained on the basis of a function (the left, first bull's eye plot), perfusion (the middle, second bull's eye plot) and viability (the right, third bull's eye plot) scan, using interpolation of missing bull's eye plot values. The plots appear to be smooth because the missing pixel values in the bull's eye plots are interpolated. Each location in the bull's eye plot relates to a particular location at the myocardium. Consequently, it becomes easier to relate findings from different scans. For example, from these bull's eye plots, it is immediately evident that the perfusion deficit 31 relates to a wall motion abnormality 32 and to a scar 33. It is worth pointing out that the range of different scans is also different. Thus, the blank areas in the bull's eye plots (visible as black areas of zero intensity and corresponding to the absence of image data) are different in each plot.

[0044] A person skilled in the art will understand that a number of various embodiments of the system 200 are possible. These embodiments may differ from each other, for example, with respect to the parameterization of the bull's eye plot. The radius of the bull's eye plot may be parameterized by the distance from the apex to the data slice or the distance from the valve plane to the data slice.

[0045] In an embodiment of the system 200, the length of the radius of each ring of the bull's eye plot is computed on the basis of the ratio of the distance from the apex to the data slice associated with the ring, to the distance between the apex and the valve plane. Alternatively, the distance between other two landmarks of the heart and/or of the surrounding anatomy may be used to compute the ratio.

[0046] In an embodiment of the system 200, the radius unit is arranged for finding a position of at least one landmark in the image data. The skilled person will know various methods, e.g. segmentation methods, suitable for finding positions of such landmarks.

[0047] In an embodiment of the system 200, the length of the radius of each ring of the bull's eye plot is computed by the radius unit 215 on the basis of the thickness of data slices of the first plurality of data slices. For example, the length of the internal radius of the ring may be proportional to the sum of thicknesses of data slices of the plurality of data slices and, if the slices are not contiguous, of widths of inter-slice gaps, which data slices and inter-slice gaps are located between the data slice associated with the ring and a reference data slice. The length of the external radius of the ring may be equal to the sum of the thickness of the data slice associated with the ring and the internal ring radius. The reference data slice may be determined based on image data segmentation, for example, to comprise a reference landmark, e.g., the apex.

[0048] If two or more image data sets, each image data set comprising a plurality of data slices, are acquired in one exam such that the position of the patient with respect to the image acquisition apparatus is the same during each image data set acquisition, the radius of the ring of the bull's eye plot may be defined based on the position of the data slice associated with the ring in a laboratory system of reference. A laboratory system of reference is a system of reference defined with respect to the image acquisition apparatus. The z axis of the laboratory system is typically perpendicular to the data slices and substantially coincides with the long axis of the left ventricle of the myocardium. The radius of each ring of each bull's eye plot is computed based on the position of the data slice with respect to the z axis of the laboratory system.

In this embodiment it is not necessary to determine landmark positions.

[0049] Furthermore, different embodiments may involve interpolation of different orders, i.e. linear, quadric, cubic, etc. Alternatively, the ring gaps corresponding to gaps between the data slices may remain blank in the bull's eye plot. The width of the ring may be related to the thickness of the data slice in the image stack comprising the plurality of data slices and the width of the ring gap may represent the width of the gap in the image stack of data slices associated with said ring gap.

[0050] The system 200 further comprises an indicator input unit, implemented within the user interface 265, for receiving a user input for indicating a first location in the first bull's eye plot, using a first indicator, and a second location in the second bull's eye plot, using a second indicator, and an indicator unit, implemented within the user interface 265, for indicating the first location in the first bull's eye plot, using the first indicator, and the second location in the second bull's eye plot, using the second indicator, wherein the first and second locations are substantially the same relative to the respective first and second bull's eye plots. Thus, the first and second locations correspond to substantially identical locations in the first and second image data. This is possible because of the reparametrization of the bull's eye plot.

[0051] Fig. 4 shows exemplary bull's eye plots, each plot showing an indicated location, and exemplary images computed from data slices associated with rings comprising the indicated locations. Each location is indicated by a cross. The location of the cross in one of the bull's eye plots is determined by a pointer controlled by a mouse controlled by a user. The two other locations are computed based on said one location in such a way that all three locations are identical relative to the respective bull's eye plots. Fig. 4 illustrates an exemplary interactive comprehensive view based on cardiac MR data according to the invention. The mouse pointer (the cross) is used to indicate a scar in the bull's eye plot derived from the viability image. Linked pointers indicate the same location in the other bull's eye plots. A person skilled in the art will understand that, in principle, the linked pointers can be used to indicate corresponding locations in a plurality of bull's eye plots visualizing results of a plurality of analyses of a plurality of image data sets of an organ, even if the bull's eye plots are not reparametrized. In this case, each linked pointer may point at a different location in each bull's eye plot.

[0052] In addition, the system 200 may be further adapted for displaying images computed from data slices associated with bull's eye plot rings, comprising a location indicated by the pointer, as shown in Fig. 4. Each image computed from a data slice may further include a pointer for indicating a location corresponding to the location in the ring associated with the shown slice. Those skilled in the art will appreciate that the one-to-one correspondence between a location in a bull's eye plot and a location in the data slice associated with a ring comprising said location allows the input to be based either on a pointer location in the bull's eye plot or on a pointer location in a data slice. The user may inspect the stack of data slices, select a slice and indicate a location in a data slice which is of interest to him. The system (200) may be adapted for computing the corresponding location in the bull's eye plot. Additionally or alternatively, the ring associated with the selected slice may be shown in the bull's eye plot.

[0053] Fig. 5 shows exemplary bull's eye plots, each plot showing an indicated ring, and exemplary images computed from data slices associated with the indicated rings. Fig. 5 illustrates an exemplary interactive comprehensive view based on cardiac MR data. The mouse pointer (the cross) is used to indicate a perfusion deficit in the perfusion image. In each bull's eye plot, the circles indicate the rings associated with the data slices corresponding to the location of the perfusion deficit.

[0054] The above embodiment of the system 200 implements a new method of interactive simultaneous visualization of the results from a comprehensive cardiac exam. The disclosed user interaction allows "result-driven" browsing through the acquired images by using the location of the mouse pointer in the bull's eye plots to display the slice related to that measurement. This interaction can be used in a linked fashion, such that a number of bull's eye plots can be used to select a slice of interest from a number of acquisitions. Thus, it is possible to construct an interactive viewing application that displays the acquired images and bull's eye plots from function, perfusion and viability simultaneously. Pointing at a perfusion deficit in a bull's eye plot highlights quantitative results in the other bull's eye plots and selects the slices corresponding to the location pointed at in all three scans, as shown in Figs. 4 and 5. Additionally, the viewing application may indicate the selected slices in the bull's eye plots by means of rings, as shown in Figs. 5.

[0055] The proposed user interaction provides a powerful mechanism to quickly select images from diseased locations in the heart based on quantitative cardiac analysis results. Furthermore, the simultaneous display of bull's eye plots and images from function, perfusion and viability allows cardiologist to diagnose in a very direct and simple approach. Furthermore, using the system 200 it is easy to select key images, often from a total of more than 2000 images, to be included in the final report.

[0056] In an embodiment, the system 200 is adapted for enabling the user, e.g. a cardiologist, to interactively delineate the myocardial contours in the examined image data. By displaying delineated contours and the acquired images, the cardiologist can quickly assess whether the delineation has been performed correctly, especially for a location with interesting measurement values.

[0057] Advantageously, the system 200 may be comprised in a reporting system 600. Thus, the system 200 may be included in a medical report created by a report unit 610 together with annotations by a physician examining the bull's eye plot. In an embodiment, the reporting system 600 comprises a reporting system first input connector 601 for obtaining data needed by the system 200 and a reporting system second input connector 602 for obtaining other data such as user annotations, patient name and age, other test and examination results, comments by a physician preparing the report, and so on. The reporting unit 610 is arranged to receive the bull's eye plots from the system 200. The report is outputted via a reporting system output connector 603.

[0058] The units of the system 200 may be implemented using a processor. Normally, their functions are performed under the control of a software program product. During execution, the software program product is normally loaded into a memory, like a RAM, and executed from there. The program may be loaded from a background memory, such as a ROM, hard disk, or magnetic and/or optical storage, or may be loaded via a network like the Internet. Optionally, an application-specific integrated circuit may provide the described functionality.

[0059] Fig. 7 shows a flowchart of an exemplary implementation of the method 700 of visualizing, in a first bull's eye plot, results of a first quantitative analysis of an object represented in first image data, the first image data comprising a first plurality of data slices. The method 700 begins with a slice step 710 for associating a data slice of the first plurality of data slices with a concentric ring of the first bull's eye plot. Optionally, the slice step may further involve a plurality of slice-sector steps 712 for associating the data sector of the data slice with a ring sector of the concentric ring. After the slice step 710, the method 700 continues to a radius step 715 for computing the length of a radius of the concentric ring of the first bull's eye plot. After the radius step 715, the method 700 continues to a value step 720 for computing at least one value for displaying in the concentric ring of the first bull's eye plot, on the basis of the data slice associated with the concentric ring of the first bull's eye plot. Optionally, the value step 220 may comprise a plurality of sector-value steps 722 for computing at least one value for displaying in the ring sector of the concentric ring, on the basis of the data sector associated with the ring sector of the concentric ring, and wherein the position of the ring sector with respect to the concentric ring is defined on the basis of the position of the data sector associated with the ring sector, with respect to the object. Optionally, after the value step 720, the method 700 continues to an approximation step 730 for computing at least one value for displaying in a concentric ring gap of the first bull's eye plot on the basis of data slices of the first plurality of data slices associated with concentric rings adjacent to the ring gap. After the value step 720 or after the approximation step 730, the method 700 terminates. In the method 700, the length of the radius of the concentric ring of the first bull's eye plot is defined on the basis of the position of the data slice, of the first plurality of data slices, associated with the concentric ring of the first bull's eye plot, with respect to the object.

[0060] The radius step 215 and the value step 220 may be computed concurrently.

[0061] Fig. 8 schematically shows an exemplary embodiment of the image acquisition apparatus 800 employing the system 200, said image acquisition apparatus 800 comprising a CT image acquisition unit 810 connected via an internal connection with the system 200, an input connector 801, and an output connector 802. This arrangement advantageously increases the capabilities of the image acquisition apparatus 800, providing said image acquisition apparatus 800 with advantageous capabilities of the system 200.

[0062] Fig. 9 schematically shows an exemplary embodiment of the workstation 900. The workstation comprises a system bus 901. A processor 910, a memory 920, a disk input/output (I/O) adapter 930, and a user interface (UI) 940 are operatively connected to the system bus 901. A disk storage device 931 is operatively coupled to the disk I/O adapter 930. A keyboard 941, a mouse 942, and a display 943 are operatively coupled to the UI 940. A computer program is stored in the disk storage device 931. The workstation 900 is arranged to load the program and input data into memory 920 and execute the program on the processor 910. The user can input information to the workstation 900, using the keyboard 941 and/or the mouse 942. The workstation is arranged to output information to the display device 943 and/or to the disk 931. A person skilled in the art will understand that there are numerous other embodiments of the workstation 900 known in the art and that the present embodiment serves the purpose of illustrating the invention and must not be interpreted as limiting the invention to this particular embodiment.

[0063] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention and that those skilled in the art will be able to design alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps not listed in a claim or in the description. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention can be implemented by means of hardware comprising several distinct elements and by means of a programmed computer. In the system claims enumerating several units, several of these units can be embodied by one and the same item of hardware or software. The usage of the words first, second, third, etc., does not indicate any ordering. These words are to be interpreted as names.

Claims

1. A system (200) for visualizing, in a first bull's eye plot, results of a first quantitative analysis of an object represented in first image data, the first image data comprising a first plurality of data slices, the system

(200) comprising:

- a slice unit (210) for associating a data slice of the first plurality of data slices with a concentric ring of the first bull's eye plot;
- a radius unit (215) for computing the length of a radius of the concentric ring of the first bull's eye plot; and
- a value unit (220) for computing at least one value for displaying in the concentric ring of the first bull's eye plot, on the basis of the data slice associated with the concentric ring of the first bull's eye plot;

and wherein the length of the radius of the concentric ring of the first bull's eye plot is defined on the basis of the position of the data slice, of the first plurality of data slices, associated with the concentric ring of the first bull's eye plot, with respect to the object; wherein the system is further adapted for visualizing, in a second bull's eye plot, results of a second quantitative analysis of the object represented in second image data, the second image data comprising a second plurality of data slices, wherein:

- the slice unit (210) is adapted for associating a data slice of the second plurality of data slices with a concentric ring of the second bull's eye plot;
- the radius unit (215) is adapted for computing the length of a radius of the concentric ring of the second bull's eye plot; and
- the value unit (220) is adapted for computing at least one value for displaying in the concentric ring of the second bull's eye plot on the basis of the data slice associated with the concentric ring of the second bull's eye plot;

and wherein the length of the radius of the concentric ring of the second bull's eye plot is defined on the basis of the position of the data slice, of the second plurality of data slices, associated with the concentric ring of the second bull's eye plot, with respect to the object; **characterised in that** the system further comprises:

- an indicator input unit (265) for receiving a user input for indicating a first location in the first bull's eye plot, using a first indicator, and a second location in the second bull's eye plot, using a second indicator; and
- an indicator unit (265) for indicating the first location in the first bull's eye plot, using the first indicator, and the second location in the second bull's eye plot, using the second indicator, based on the user input;

wherein the first and second locations are the same relative to the respective first and second bull's eye plots.

2. A system (200) as claimed in claim 1, wherein the data slice associated with the concentric ring comprises a data sector, wherein the slice unit (210) further comprises a slice-sector unit (212) for associating the data sector of the data slice with a ring sector of the concentric ring, wherein the value unit (220) comprises a sector-value unit (222) for computing at least one value for displaying in the ring sector of the concentric ring, on the basis of the data sector associated with the ring sector of the concentric ring, and wherein the position of the ring sector with respect to the concentric ring is defined on the basis of the position of the data sector associated with the ring sector, with respect to the object.

3. A system (200) as claimed in claim 1, wherein the first bull's eye plot comprises a concentric ring gap corresponding to an inter-slice gap.

4. A system (200) as claimed in claim 3, further comprising an approximation unit (230) for computing at least one value for displaying in the concentric ring gap of the first bull's eye plot on the basis of data slices of the first plurality of data slices associated with concentric rings adjacent to the ring gap.

5. A system (200) as claimed in claim 4, wherein the at least one value for displaying in the concentric ring gap of the first bull's eye plot is computed on the basis of values for displaying in the concentric rings adjacent to the ring gap, which values are computed on the basis of data slices of the first plurality of data slices, associated with the concentric rings adjacent to the gap.

6. A system (200) as claimed in claim 1, wherein the length of the radius of the concentric ring of the first bull's eye plot is computed on the basis of a distance between the data slice of the first plurality of data slices, associated with the concentric ring, and a certain feature of the object.

7. A system (200) as claimed in claim 6, wherein the width of the concentric ring of the first bull's eye plot is computed on the basis of the thickness of the data slice of the first plurality of data slices.

8. A system (200) as claimed in claim 1, wherein the lengths of the radiuses of the concentric ring of the first bull's eye plot and of the concentric ring of the second bull's eye plot are computed on the basis of distances from, respectively, the data slice of the first plurality of data slices and the data slice of the second plurality of data slices to a certain feature of the object.

9. A system (200) as claimed in claim 1, further comprising a slice determination unit (240) for determining a first ring comprising the first location, based on a first data slice associated with the first ring and for determining a second ring comprising the second location, based on a second data slice associated with the second ring.

10. A system (200) as claimed in claim 9, wherein the user input for indicating the first location in the first bull's eye plot comprises a certain location in a certain data slice of the first plurality of data slices.

11. An image acquisition apparatus (800) comprising a system (200) as claimed in claim 1.

12. A workstation (900) comprising a system (200) as claimed in claim 1.

13. A system-implemented method (700) of visualizing, in a first bull's eye plot, results of a first quantitative analysis of an object represented in first image data, the first image data comprising a first plurality of data slices, the method (700) comprising:

- a slice step (710) for associating a data slice of the first plurality of data slices with a concentric ring of the first bull's eye plot;
- a radius step (715) for computing the length of a radius of the concentric ring of the first bull's eye plot; and
- a value step (720) for computing at least one value for displaying in the concentric ring of the first bull's eye plot, on the basis of the data slice associated with the concentric ring of the first bull's eye plot;

wherein the length of the radius of the concentric ring of the first bull's eye plot is defined on the basis of the position of the data slice, of the first plurality of data slices, associated with the concentric ring of the first bull's eye plot, with respect to the object; wherein the method is further adapted for visualizing, in a second bull's eye plot, results of a second quantitative analysis of the object represented in second image data, the second image data comprising a second plurality of data slices, wherein:

- the slice step (710) is adapted for associating a data slice of the second plurality of data slices with a concentric ring of the second bull's eye plot;
- the radius step (715) is adapted for computing the length of a radius of the concentric ring of the second bull's eye plot; and
- the value step (720) is adapted for computing at least one value for displaying in the concentric ring of the second bull's eye plot on the basis of the data slice associated with the concentric ring of the second bull's eye plot;

and wherein the length of the radius of the concentric ring of the second bull's eye plot is defined on the basis of the position of the data slice, of the second plurality of data slices, associated with the concentric ring of the second bull's eye plot, with respect to the object;
and wherein the method further comprises:

- an indicator input step for receiving a user input for indicating a first location in the first bull's eye plot, using a first indicator, and a second location in the second bull's eye plot, using a second indicator; and
- an indicator step for indicating the first location in the first bull's eye plot, using the first indicator, and the second location in the second bull's eye plot, using the second indicator, based on the user input;

wherein the first and second locations are the same relative to the respective first and second bull's eye plots.

14. A computer program product to be loaded by a computer arrangement, comprising instructions for visualizing, in a first bull's eye plot, results of a first quantitative analysis of an object represented in first image data, the first image data comprising a first plurality of data slices, the computer arrangement comprising a processing unit and a memory, the computer program product, after being loaded, providing said processing unit with the capability to carry out the following tasks:

- associating a data slice of the first plurality of data slices with a concentric ring of the first bull's eye plot;
- computing the length of a radius of the concentric ring of the first bull's eye plot; and
- computing at least one value for displaying in the concentric ring of the first bull's eye plot, on the basis of the data slice associated with the concentric ring of the first bull's eye plot;

and wherein the length of the radius of the concentric ring of the first bull's eye plot is defined on the basis of the position of the data slice, of the first plurality of data slices, associated with the concentric ring of the first bull's eye plot, with respect to the object;
wherein the computer program comprises further instructions for visualizing, in a second bull's eye plot, results of a second quantitative analysis of the object represented in second image data, the second image data comprising a second plurality of data slices, wherein the computer program product, after being

loaded, provides said processing unit with the capability to carry out the following further tasks:

- associating a data slice of the second plurality of data slices with a concentric ring of the second bull's eye plot;
- computing the length of a radius of the concentric ring of the second bull's eye plot; and
- computing at least one value for displaying in the concentric ring of the second bull's eye plot on the basis of the data slice associated with the concentric ring of the second bull's eye plot;

and wherein the length of the radius of the concentric ring of the second bull's eye plot is defined on the basis of the position of the data slice, of the second plurality of data slices, associated with the concentric ring of the second bull's eye plot, with respect to the object;
and wherein the computer program product, after being loaded, provides said processing unit with the capability to carry out the following further tasks:

- receiving a user input for indicating a first location in the first bull's eye plot, using a first indicator, and a second location in the second bull's eye plot, using a second indicator; and
- indicating the first location in the first bull's eye plot, using the first indicator, and the second location in the second bull's eye plot, using the second indicator, based on the user input;

wherein the first and second locations are the same relative to the respective first and second bull's eye plots.

Patentansprüche

1. System (200) zur Visualisierung, in einem ersten Zielscheibendiagramm, der Ergebnisse einer ersten quantitativen Analyse eines in ersten Bilddaten dargestellten Objekts, wobei die ersten Bilddaten eine erste Vielzahl von Datenscheiben umfassen, wobei das System (200) Folgendes umfasst:

- eine Scheibeneinheit (210) zum Zuordnen einer Datenscheibe aus der ersten Vielzahl von Datenscheiben zu einem konzentrischen Ring des ersten Zielscheibendiagramms;
- eine Radiuseinheit (215) zum Berechnen der Länge eines Radius des konzentrischen Rings des ersten Zielscheibendiagramms; und
- eine Werteinheit (220) zum Berechnen von mindestens einem Wert für die Anzeige in dem konzentrischen Ring des ersten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe;

und wobei die Länge des Radius des konzentrischen Rings des ersten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe aus der ersten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird;
wobei das System weiterhin dafür ausgelegt ist, in einem zweiten Zielscheibendiagramm die Ergebnisse einer zweiten quantitativen Analyse des in zweiten Bilddaten dargestellten Objekts zu visualisieren, wobei die zweiten Bilddaten eine zweite Vielzahl von Datenscheiben umfassen, wobei:

- die Scheibeneinheit (210) dafür ausgelegt ist, eine Datenscheibe aus der zweiten Vielzahl von Datenscheiben einem konzentrischen Ring des zweiten Zielscheibendiagramms zuzuordnen;
- die Radiuseinheit (215) dafür ausgelegt ist, die Länge eines Radius des konzentrischen Rings des zweiten Zielscheibendiagramms zu berechnen; und
- die Werteinheit (220) dafür ausgelegt ist, mindestens einen Wert für die Anzeige in dem konzentrischen Ring des zweiten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe zu berechnen;

und wobei die Länge des Radius des konzentrischen Rings des zweiten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe aus der zweiten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird;
dadurch gekennzeichnet, dass das System weiterhin Folgendes umfasst:

- eine Indikatoreingabeeinheit (265) zum Empfangen einer Benutzereingabe zum Angeben eines ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung eines ersten Indikators und eines zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung eines zweiten Indikators; und
- eine Indikatoreinheit (265) zum Angeben des ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung des ersten Indikators und des zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung des zweiten Indikators basierend auf der Benutzereingabe;

wobei der erste und der zweite Ort in Bezug auf das jeweilige erste und zweite Zielscheibendiagramm die gleichen sind.

2. System (200) nach Anspruch 1, wobei die zu dem konzentrischen Ring gehörende Datenscheibe einen Datensektor umfasst, wobei die Scheibeneinheit (210) weiterhin eine Scheibensektoreinheit (212) zum Zuordnen des Datensektors der Datenscheibe zu einem Ringsektor des konzentrischen Rings umfasst, wobei die Werteinheit (220) eine Sektorwerteinheit (222) zum Berechnen von mindestens einem Wert für die Anzeige in dem Ringsektor des konzentrischen Rings basierend auf dem zu dem Ringsektor des konzentrischen Rings gehörenden Datensektor umfasst, und wobei die Position des Ringsektors in Bezug auf den konzentrischen Ring basierend auf der Position des zu dem Ringsektor gehörenden Datensektor in Bezug auf das Objekt definiert wird.

3. System (200) nach Anspruch 1, wobei das erste Zielscheibendiagramm eine konzentrische Ringlücke umfasst, die einer Zwischenscheibenlücke entspricht.

4. System (200) nach Anspruch 3, weiterhin umfassend eine Approximierungseinheit (230) zum Berechnen von mindestens einem Wert für die Anzeige in der konzentrischen Ringlücke des ersten Zielscheibendiagramms basierend auf zu den konzentrischen Ringen, die an die Ringlücke angrenzen, gehörenden Datenscheiben aus der ersten Vielzahl von Datenscheiben.

5. System (200) nach Anspruch 4, wobei der mindestens eine Wert für die Anzeige in der konzentrischen Ringlücke des ersten Zielscheibendiagramms basierend auf Werten für die Anzeige in den konzentrischen Ringen, die an die Ringlücke angrenzen, berechnet wird, wobei diese Werte basierend auf zu den konzentrischen Ringen, die an die Lücke angrenzen, gehörenden Datenscheiben aus der ersten Vielzahl von Datenscheiben berechnet werden.

6. System (200) nach Anspruch 1, wobei die Länge des Radius des konzentrischen Rings des ersten Zielscheibendiagramms basierend auf einem Abstand zwischen der zu dem konzentrischen Ring gehörenden Datenscheibe aus der ersten Vielzahl von Datenscheiben und einem bestimmten Merkmal des Objekts berechnet wird.

7. System (200) nach Anspruch 6, wobei die Breite des konzentrischen Rings des ersten Zielscheibendiagramms basierend auf der Dicke der Datenscheibe aus der ersten Vielzahl von Datenscheiben berechnet wird.

8. System (200) nach Anspruch 1, wobei die Länge des Radius des konzentrischen Rings des ersten Zielscheibendiagramms und die Länge des Radius des konzentrischen Rings des zweiten Zielscheibendiagramms basierend auf dem Abstand der Datenscheibe aus der ersten Vielzahl von Datenscheiben bzw. auf dem Abstand der Datenscheibe aus der zweiten Vielzahl von Datenscheiben zu einem bestimmten Merkmal des Objekts berechnet wird.

9. System (200) nach Anspruch 1, weiterhin umfassend eine Scheibenermittlungseinheit (240) zum Ermitteln eines den ersten Ort umfassenden ersten Rings basierend auf einer zu dem ersten Ring gehörenden ersten Datenscheibe und zum Ermitteln eines den zweiten Ort umfassenden zweiten Rings basierend auf einer zu dem zweiten Ring gehörenden zweiten Datenscheibe.

10. System (200) nach Anspruch 9, wobei die Benutzereingabe zum Angeben des ersten Orts in dem Zielscheibendiagramm einen bestimmten Ort in einer bestimmten Datenscheibe aus der ersten Vielzahl von Datenscheiben umfasst.

11. Bilderfassungsgerät (800) umfassend ein System (200) nach Anspruch 1.

12. Workstation (900) umfassend ein System (200) nach Anspruch 1.

13. System-implementiertes Verfahren (700) zur Visualisierung, in einem ersten Zielscheibendiagramm, der Ergebnisse einer ersten quantitativen Analyse eines in ersten Bilddaten dargestellten Objekts, wobei die ersten Bilddaten eine erste Vielzahl von Datenscheiben umfassen, wobei das Verfahren (700) Folgendes umfasst:

- einen Scheibenschritt (710) zum Zuordnen einer Datenscheibe aus der ersten Vielzahl von Datenscheiben zu einem konzentrischen Ring des ersten Zielscheibendiagramms;
- einen Radiusschritt (715) zum Berechnen der Länge eines Radius des konzentrischen Rings des ersten Zielscheibendiagramms; und
- einen Wertschritt (720) zum Berechnen von mindestens einem Wert für die Anzeige in dem konzentrischen Ring des ersten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe;

und wobei die Länge des Radius des konzentrischen Rings des ersten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe aus der ersten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird;
wobei das Verfahren weiterhin dafür ausgelegt ist, in einem zweiten Zielscheibendiagramm die Ergeb-

nisse einer zweiten quantitativen Analyse des in zweiten Bilddaten dargestellten Objekts zu visualisieren, wobei die zweiten Bilddaten eine zweite Vielzahl von Datenscheiben umfassen, wobei:

- der Scheibenschritt (710) dafür ausgelegt ist, eine Datenscheibe aus der zweiten Vielzahl von Datenscheiben einem konzentrischen Ring des zweiten Zielscheibendiagramms zuzuordnen;
- der Radiusschritt (715) dafür ausgelegt ist, die Länge eines Radius des konzentrischen Rings des zweiten Zielscheibendiagramms zu berechnen; und
- der Wertschritt (720) dafür ausgelegt ist, mindestens einen Wert für die Anzeige in dem konzentrischen Ring des zweiten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe zu berechnen;

und wobei die Länge des Radius des konzentrischen Rings des zweiten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe aus der zweiten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird; und wobei das Verfahren weiterhin Folgendes umfasst:

- einen Indikatoreingabeschritt zum Empfangen einer Benutzereingabe zum Angeben eines ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung eines ersten Indikators und eines zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung eines zweiten Indikators; und
- einen Indikatorschritt zum Angeben des ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung des ersten Indikators und des zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung des zweiten Indikators basierend auf der Benutzereingabe;

wobei der erste und der zweite Ort in Bezug auf das jeweilige erste und zweite Zielscheibendiagramm die gleichen sind.

14. Computerprogrammprodukt zum Laden durch eine Computeranordnung, umfassend Anweisungen zum Visualisieren, in einem ersten Zielscheibendiagramm, der Ergebnisse einer ersten quantitativen Analyse eines in ersten Bilddaten dargestellten Objekts, wobei die ersten Bilddaten eine erste Vielzahl von Datenscheiben umfassen, wobei die Computeranordnung eine Verarbeitungseinheit und einen Speicher umfasst, wobei das Computerprogrammprodukt, nachdem es geladen wurde, der genannten Verarbeitungseinheit die Fähigkeit vermittelt, die folgenden Aufgaben auszuführen:

- Zuordnen einer Datenscheibe aus der ersten Vielzahl von Datenscheiben zu einem konzentrischen Ring des ersten Zielscheibendiagramms;
- Berechnen der Länge eines Radius des konzentrischen Rings des ersten Zielscheibendiagramms; und
- Berechnen von mindestens einem Wert für die Anzeige in dem konzentrischen Ring des ersten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe;

und wobei die Länge des Radius des konzentrischen Rings des ersten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des ersten Zielscheibendiagramms gehörenden Datenscheibe aus der ersten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird;
wobei das Computerprogramm weiterhin Anweisungen zum Visualisieren, in einem zweiten Zielscheibendiagramm, der Ergebnisse einer zweiten quantitativen Analyse des in zweiten Bilddaten dargestellten Objekts umfasst, wobei die zweiten Bilddaten eine zweite Vielzahl von Datenscheiben umfassen, wobei das Computerprogrammprodukt, nachdem es geladen wurde, der genannten Verarbeitungseinheit die Fähigkeit vermittelt, die folgenden weiteren Aufgaben auszuführen:

- Zuordnen einer Datenscheibe aus der zweiten Vielzahl von Datenscheiben zu einem konzentrischen Ring des zweiten Zielscheibendiagramms;
- Berechnen der Länge eines Radius des konzentrischen Rings des zweiten Zielscheibendiagramms; und
- Berechnen von mindestens einem Wert für die Anzeige in dem konzentrischen Ring des zweiten Zielscheibendiagramms basierend auf der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe;

und wobei die Länge des Radius des konzentrischen Rings des zweiten Zielscheibendiagramms basierend auf der Position der zu dem konzentrischen Ring des zweiten Zielscheibendiagramms gehörenden Datenscheibe aus der zweiten Vielzahl von Datenscheiben in Bezug auf das Objekt definiert wird; und wobei das Computerprogrammprodukt, nachdem es geladen wurde, der genannten Verarbeitungseinheit die Fähigkeit vermittelt, die folgenden weiteren Aufgaben auszuführen:

- Empfangen einer Benutzereingabe zum Angeben eines ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung eines ersten Indikators und eines zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung eines zweiten Indikators; und
- Angeben des ersten Orts in dem ersten Zielscheibendiagramm unter Verwendung des ersten Indikators und des zweiten Orts in dem zweiten Zielscheibendiagramm unter Verwendung des zweiten Indikators basierend auf der Benutzereingabe;

wobei der erste und der zweite Ort in Bezug auf das jeweilige erste und zweite Zielscheibendiagramm die gleichen sind.

Revendications

1. Système (200) pour visualiser, dans un premier diagramme en cible, des résultats d'une première analyse quantitative d'un objet représenté dans des premières données d'image, les premières données d'image comprenant une première pluralité de tranches de données, le système (200) comprenant :

- une unité à tranche (210) pour associer une tranche de données parmi la première pluralité de tranches de données à un anneau concentrique du premier diagramme en cible ;
- une unité à rayon (215) pour calculer la longueur d'un rayon de l'anneau concentrique du premier diagramme en cible ; et
- une unité à valeur (220) pour calculer au moins une valeur à afficher dans l'anneau concentrique du premier diagramme en cible, en fonction de la tranche de données associée à l'anneau concentrique du premier diagramme en cible ;

et dans lequel la longueur du rayon de l'anneau concentrique du premier diagramme en cible est définie en fonction de la position de la tranche de données, parmi la première pluralité de tranches de données, associée à l'anneau concentrique du premier diagramme en cible, par rapport à l'objet ;
dans lequel le système est en outre adapté pour visualiser, dans un second diagramme en cible, des résultats d'une seconde analyse quantitative de l'objet représenté dans des secondes données d'image, les secondes données d'image comprenant une seconde pluralité de tranches de données, dans lequel :

- l'unité à tranche (210) est adaptée pour associer une tranche de données parmi la seconde pluralité de tranches de données à un anneau concentrique du second diagramme en cible ;
- l'unité à rayon (215) est adaptée pour calculer la longueur d'un rayon de l'anneau concentrique du second diagramme en cible ; et
- l'unité à valeur (220) est adaptée pour calculer au moins une valeur à afficher dans l'anneau concentrique du second diagramme en cible en fonction de la tranche de données associée à l'anneau concentrique du second diagramme en cible ;

et dans lequel la longueur du rayon de l'anneau concentrique du second diagramme en cible est définie en fonction de la position de la tranche de données, de la seconde pluralité de tranches de données, associée à l'anneau concentrique du second diagramme en cible, par rapport à l'objet ;
caractérisé en ce que le système comprend en outre :

- une unité à entrée d'indicateur (265) pour recevoir une entrée utilisateur pour indiquer une première localisation dans le premier diagramme en cible, en utilisant un premier indicateur, et une seconde localisation dans le second diagramme en cible, en utilisant un second indicateur ; et
- une unité à indicateur (265) pour indiquer la première localisation dans le premier diagramme en cible, en utilisant le premier indicateur, et la seconde localisation dans le second diagramme en cible, en utilisant le second indicateur, en fonction de l'entrée utilisateur ;

dans lequel les première et seconde localisations sont les mêmes relativement aux premier et second diagrammes en cible respectifs.

2. Système (200) selon la revendication 1, dans lequel la tranche de données associée à l'anneau concentrique comprend un secteur de données, dans lequel l'unité à tranche (210) comprend en outre une unité à secteur de tranche (212) pour associer le secteur de données de la tranche de données à un secteur d'anneau de l'anneau concentrique, dans lequel l'unité à valeur (220) comprend une unité à valeur de secteur (222) pour calculer au moins une valeur à afficher dans le secteur d'anneau de l'anneau concentrique, en fonction du secteur de données associé au secteur d'anneau de l'anneau concentrique, et dans lequel la position du secteur d'anneau par rapport à l'anneau concentrique est définie en fonction de la position du secteur de données associé au secteur d'anneau, par rapport à l'objet.

3. Système (200) selon la revendication 1, dans lequel le premier diagramme en cible comprend un écart d'anneau concentrique correspondant à un écart entre tranche.

4. Système (200) selon la revendication 3, comprenant en outre une unité d'approximation (230) pour calculer au moins une valeur à afficher dans l'écart d'anneau concentrique du premier diagramme en cible en fonction de tranches de données parmi la première pluralité de tranches de données associées à anneau concentriques adjacents à l'écart d'anneau.

5. Système (200) selon la revendication 4, dans lequel l'au moins une valeur à afficher dans l'écart d'anneau concentrique du premier diagramme en cible est calculée en fonction de valeurs à afficher dans les anneaux concentriques adjacents à l'écart d'anneau, lesquelles valeurs sont calculées en fonction de tranches de données parmi la première pluralité de tranches de données, associées aux anneaux concentriques adjacents à l'écart.

6. Système (200) selon la revendication 1, dans lequel la longueur du rayon de l'anneau concentrique du premier diagramme en cible est calculée en fonction d'une distance entre la tranche de données parmi la première pluralité de tranches de données, associée à l'anneau concentrique, et d'une certaine caractéristique de l'objet.

7. Système (200) selon la revendication 6, dans lequel la largeur de l'anneau concentrique du premier diagramme en cible est calculée en fonction de l'épaisseur de la tranche de données parmi la première pluralité de tranches de données.

8. Système (200) selon la revendication 1, dans lequel les longueurs des rayons de l'anneau concentrique du premier diagramme en cible et de l'anneau concentrique du second diagramme en cible sont calculées en fonction de distances de, respectivement, la tranche de données parmi la première pluralité de tranches de données et de la tranche de données parmi la seconde pluralité de tranches de données à une certaine caractéristique de l'objet.

9. Système (200) selon la revendication 1, en outre comprenant une unité à détermination de tranche (240) pour déterminer un premier anneau comprenant la première localisation, en fonction d'une première tranche de données associée au premier anneau et pour déterminer un second anneau comprenant la seconde localisation, en fonction d'une seconde tranche de données associée au second anneau.

10. Système (200) selon la revendication 9, dans lequel l'entrée utilisateur pour indiquer la première localisation dans le premier diagramme en cible comprend une certaine localisation dans une certaine tranche de données de la première pluralité de tranches de données.

11. Appareil d'acquisition d'image (800) comprenant un système (200) selon la revendication 1.

12. Poste de travail (900) comprenant un système (200) selon la revendication 1.

13. Procédé implémenté par système (700) de visualisation, dans un premier diagramme en cible, de résultats d'une première analyse quantitative d'un objet représenté dans des premières données d'image, les premières données d'image comprenant une première pluralité de tranches de données, le procédé (700) comprenant :

- une étape à tranche (710) pour associer une tranche de données parmi la première pluralité de tranches de données à un anneau concentrique du premier diagramme en cible ;
- une étape à rayon (715) pour calculer la longueur d'un rayon de l'anneau concentrique du premier diagramme en cible ; et
- une étape à valeur (720) pour calculer au moins une valeur à afficher dans l'anneau concentrique du premier diagramme en cible, en fonction de la tranche de données associée à l'anneau concentrique du premier diagramme en cible ;

dans lequel la longueur du rayon de l'anneau concentrique du premier diagramme en cible est définie en fonction de la position de la tranche de données, parmi la première pluralité de tranches de données, associée à l'anneau concentrique du premier diagramme en cible, par rapport à l'objet ;
dans lequel le procédé est en outre adapté pour visualiser, dans un second diagramme en cible, des résultats d'une seconde analyse quantitative de l'objet représenté dans des secondes données d'image, les secondes données d'image comprenant une seconde pluralité de tranches de données, dans lequel :

- l'étape à tranche (710) est adaptée pour associer une tranche de données parmi la seconde pluralité de tranches de données à un anneau concentrique du second diagramme en cible ;
- l'étape à rayon (715) est adaptée pour calculer la longueur d'un rayon de l'anneau concentrique du second diagramme en cible ; et
- l'étape à valeur (720) est adaptée pour calculer au moins une valeur à afficher dans l'anneau concentrique du second diagramme en cible en fonction de la tranche de données associée à l'anneau concentrique du second diagramme en cible ;

et dans lequel la longueur du rayon de l'anneau concentrique du second diagramme en cible est définie en fonction de la position de la tranche de données, parmi la seconde pluralité de tranches de données, associée à l'anneau concentrique du second diagramme en cible, par rapport à l'objet ; et dans lequel le procédé comprend en outre :

- une étape à entrée d'indicateur pour recevoir une entrée utilisateur pour indiquer une première localisation dans le premier diagramme en cible, en utilisant un premier indicateur, et une seconde localisation dans le second diagramme en cible, en utilisant un second indicateur ; et
- une étape à indicateur pour indiquer la première localisation dans le premier diagramme en cible, en utilisant le premier indicateur, et la seconde localisation dans le second diagramme en cible, en utilisant le second indicateur, en fonction de l'entrée utilisateur ;

dans lequel les première et seconde localisations sont les mêmes relativement aux premier et second diagrammes en cible respectifs.

14. Produit programme d'ordinateur destiné à être chargé par un agencement d'ordinateur, comprenant des instructions pour visualiser, dans un premier diagramme en cible, des résultats d'une première analyse quantitative d'un objet représenté dans des premières données d'image, les premières données d'image comprenant une première pluralité de tranches de données, l'agencement d'ordinateur comprenant une unité de traitement et une mémoire, le produit programme d'ordinateur, après être chargé, fournissant, à ladite unité de traitement, la capacité de réaliser les tâches suivantes :

- l'association d'une tranche de données parmi la première pluralité de tranches de données à un anneau concentrique du premier diagramme en cible ;
- le calcul de la longueur d'un rayon de l'anneau concentrique du premier diagramme en cible ; et
- le calcul d'au moins une valeur à afficher dans l'anneau concentrique du premier diagramme en cible, en fonction de la tranche de données associée à l'anneau concentrique du premier diagramme en cible ;

et dans lequel la longueur du rayon de l'anneau concentrique du premier diagramme en cible est définie en fonction de la position de la tranche de données, parmi la première pluralité de tranches de données, associée à l'anneau concentrique du premier diagramme en cible, par rapport à l'objet ;
dans lequel le programme d'ordinateur comprend en outre des instructions pour visualiser, dans un second diagramme en cible, des résultats d'une seconde analyse quantitative de l'objet représenté dans des secondes données d'image, les secondes données d'image comprenant une seconde pluralité de tranches de données, dans lequel le produit programme d'ordinateur, après être chargé, fournit, à ladite unité de traitement, la capacité de réaliser les tâches supplémentaires suivantes :

- l'association d'une tranche de données parmi la seconde pluralité de tranches de données à un anneau concentrique du second diagramme en cible ;
- le calcul de la longueur d'un rayon de l'anneau concentrique du second diagramme en cible ; et
- le calcul d'au moins une valeur à afficher dans l'anneau concentrique du second diagramme en cible en fonction de la tranche de données associée à l'anneau concentrique du second diagramme en cible ;

et dans lequel la longueur du rayon de l'anneau concentrique du second diagramme en cible est définie en fonction de la position de la tranche de données, parmi la seconde pluralité de tranches de données, associée à l'anneau concentrique du second diagramme en cible, par rapport à l'objet ; et dans lequel le produit programme d'ordinateur, après être chargé, fournit, à ladite unité de traitement, la capacité de réaliser les tâches supplémentaires suivantes :

- la réception d'une entrée utilisateur pour indiquer une première localisation dans le premier diagramme en cible, en utilisant un premier indicateur, et une seconde localisation dans le second diagramme en cible, en utilisant un second indicateur ; et
- l'indication de la première localisation dans le premier diagramme en cible, en utilisant le premier indicateur, et de la seconde localisation dans le second diagramme en cible, en utilisant le second indicateur, en fonction de l'entrée utilisateur ;

dans lequel les première et seconde localisations sont les mêmes relativement aux premier et second diagrammes en cible respectifs.

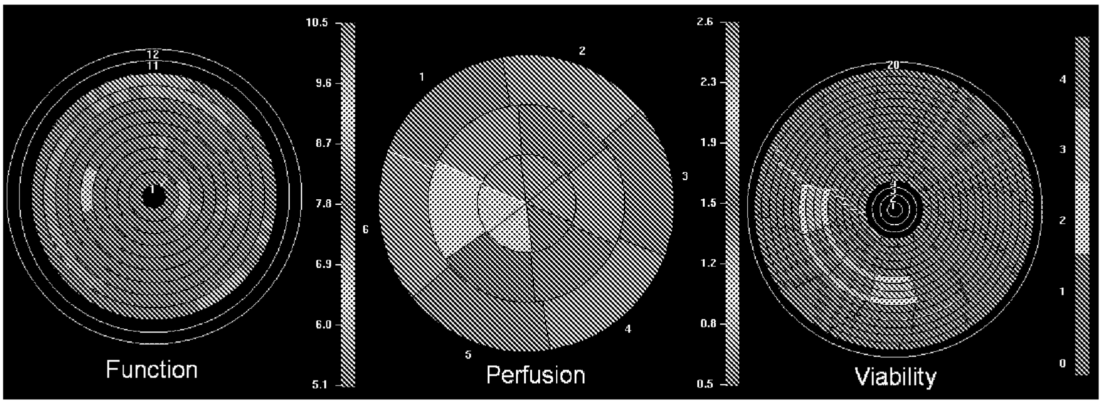

FIG. 1A
PRIOR ART

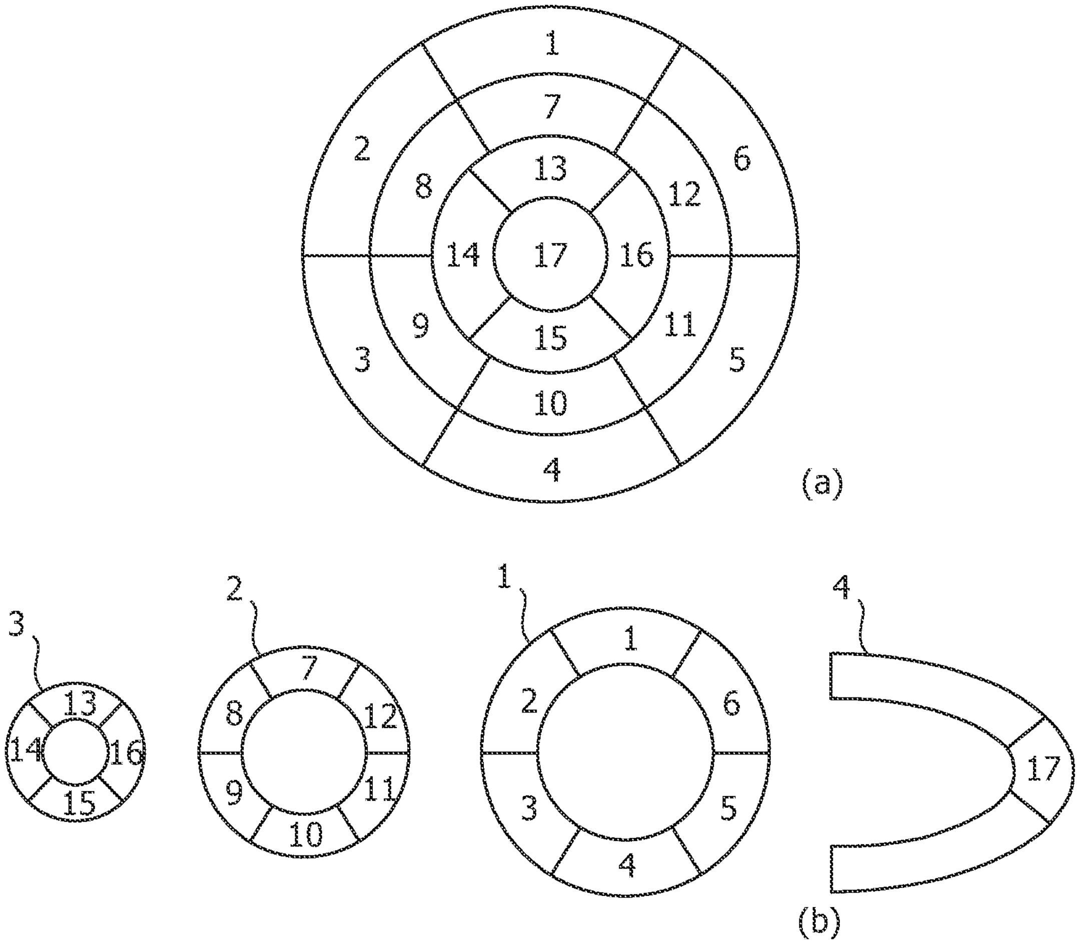

FIG. 1B
PRIOR ART

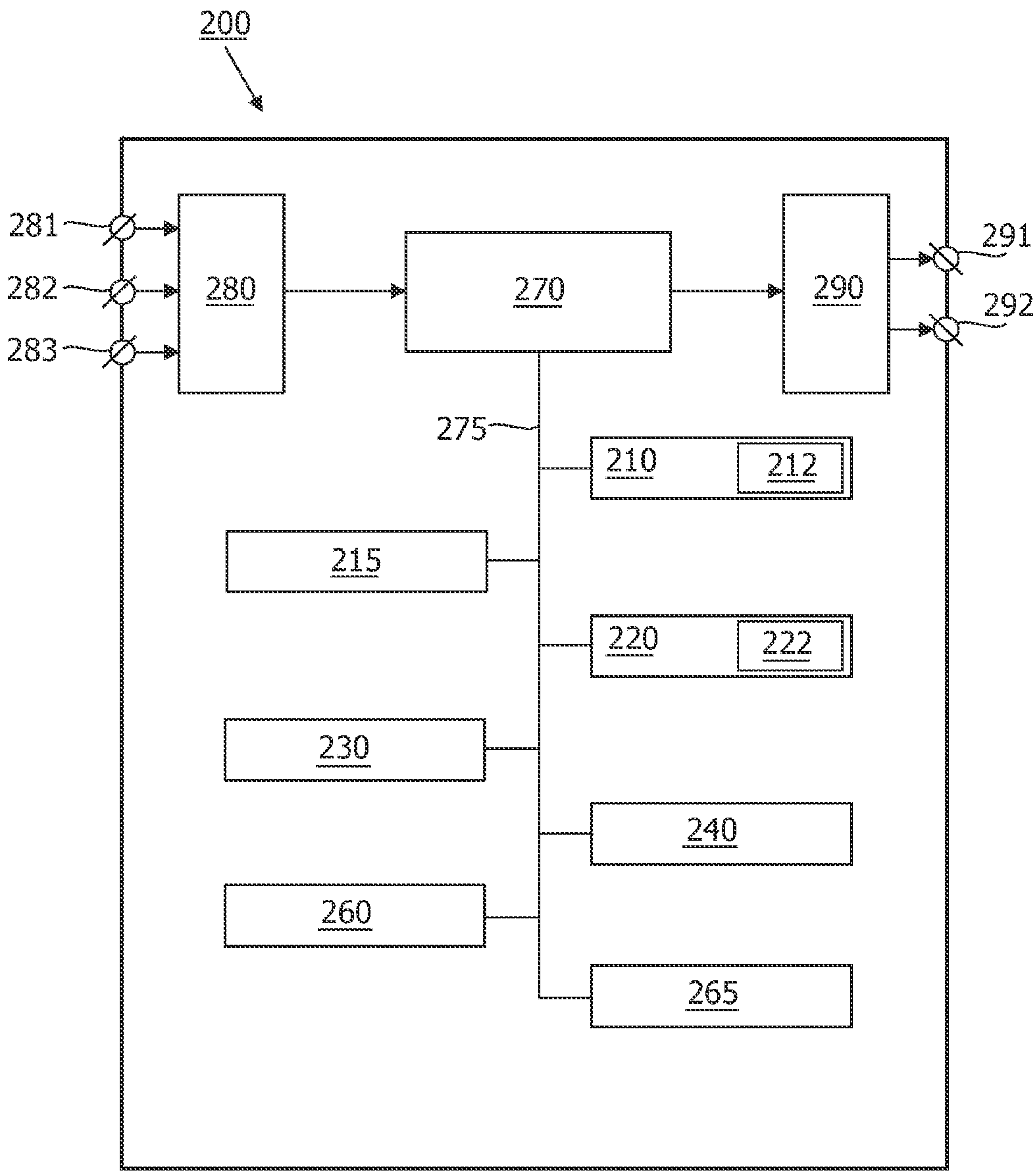
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FIG. 2

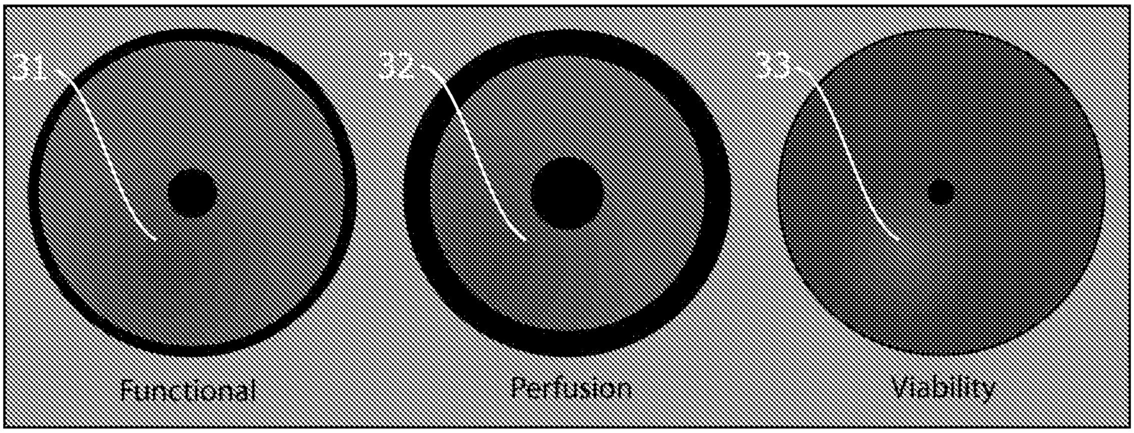
31
32
33
Functional
Perfusion
Viability

FIG. 3

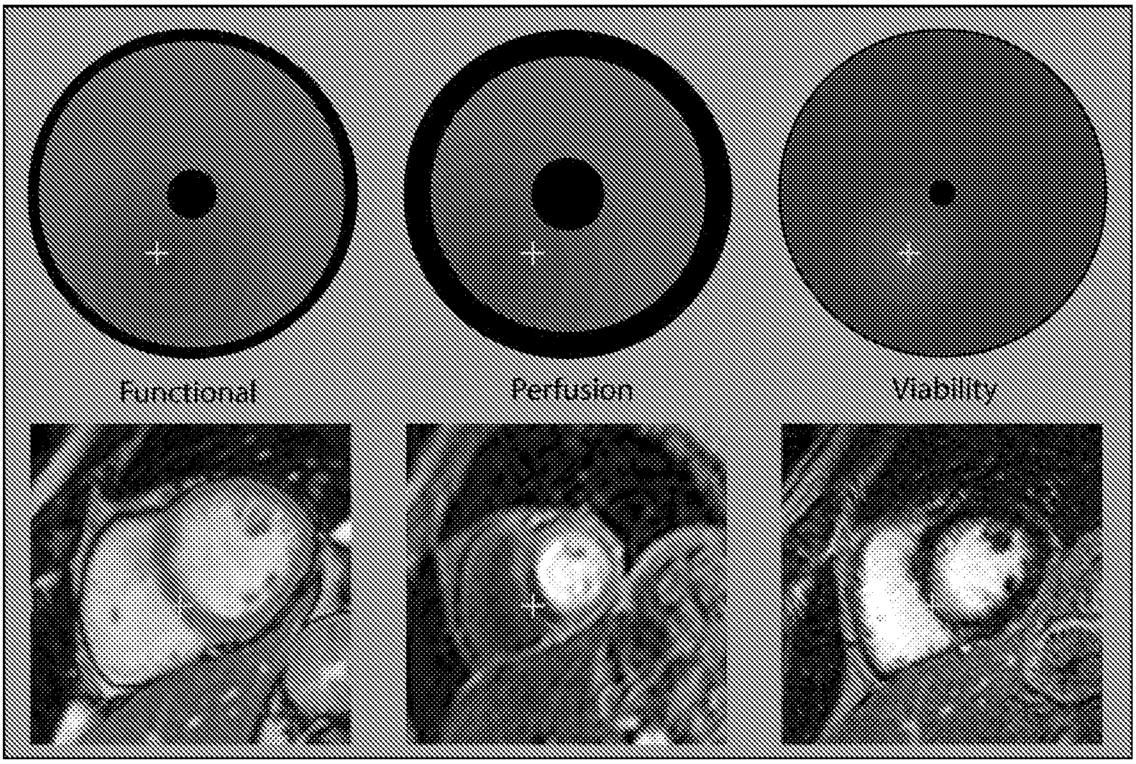
Functional
Perfusion
Viability

FIG. 4

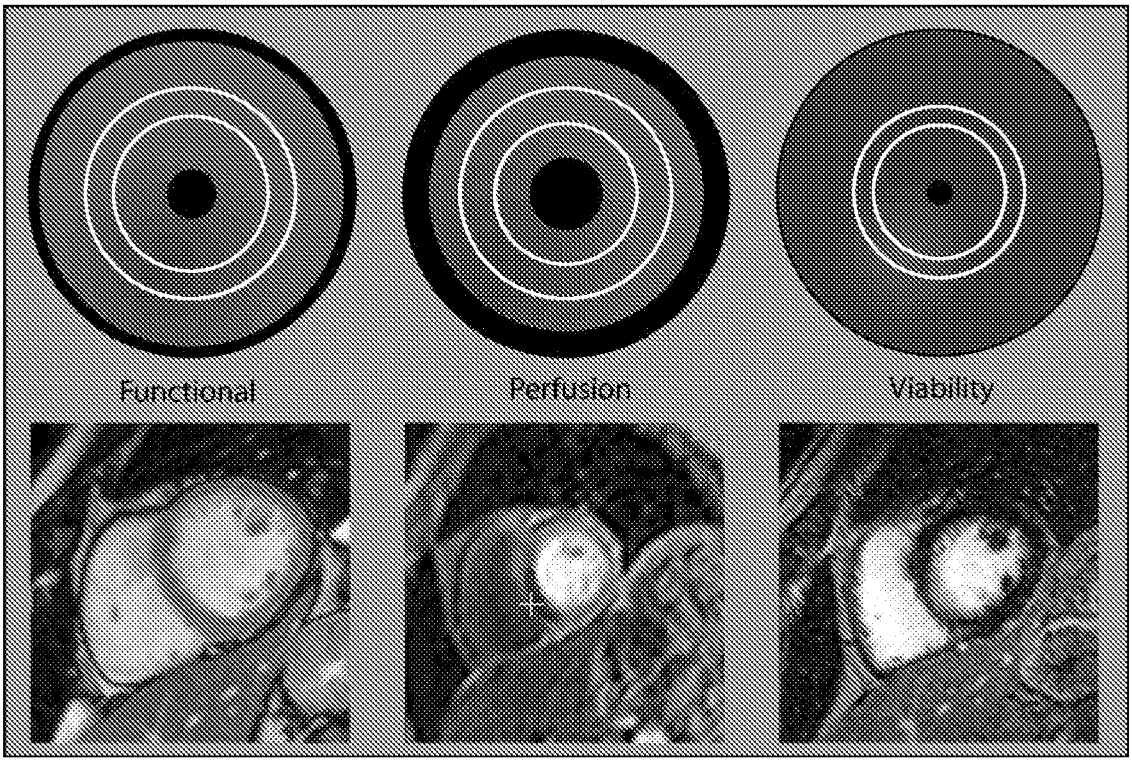

FIG. 5

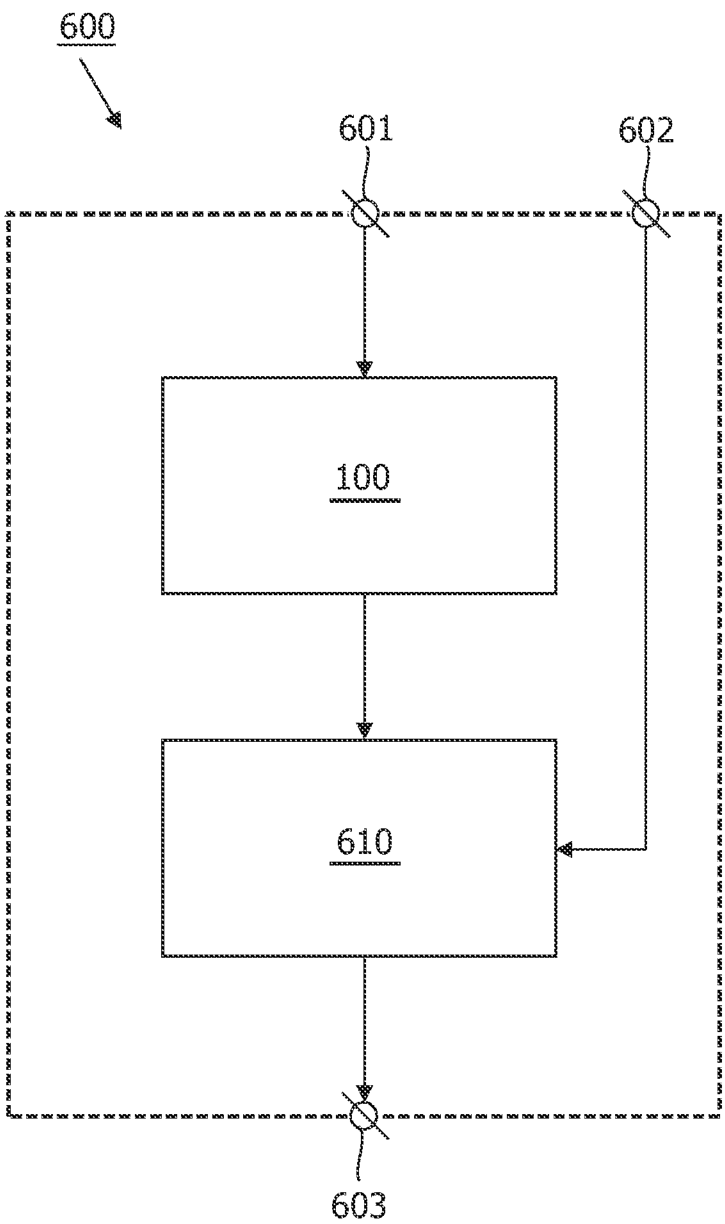

FIG. 6

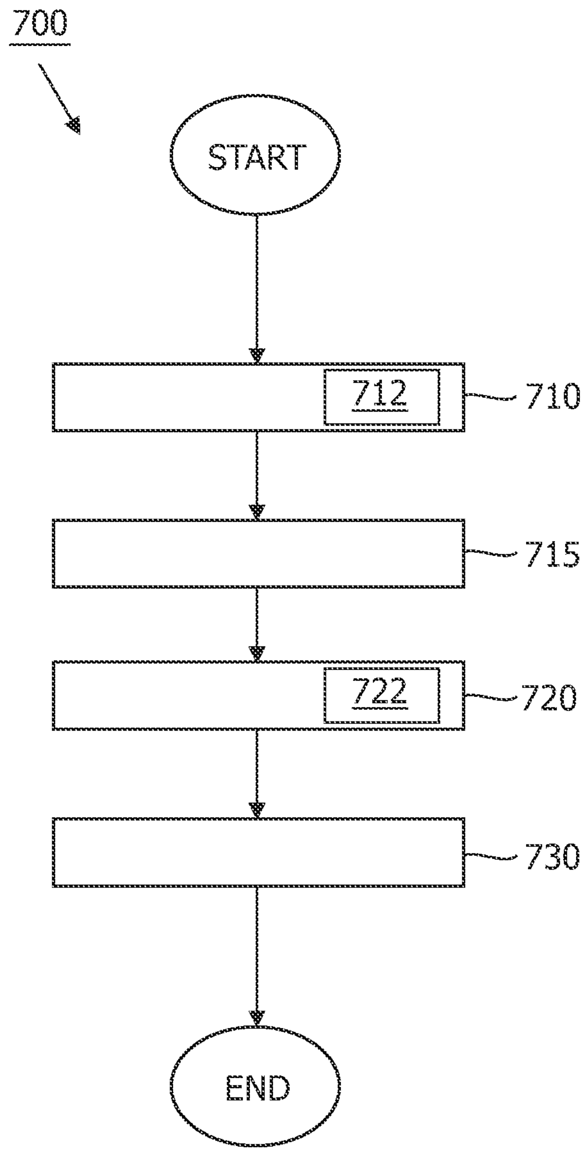

FIG. 7

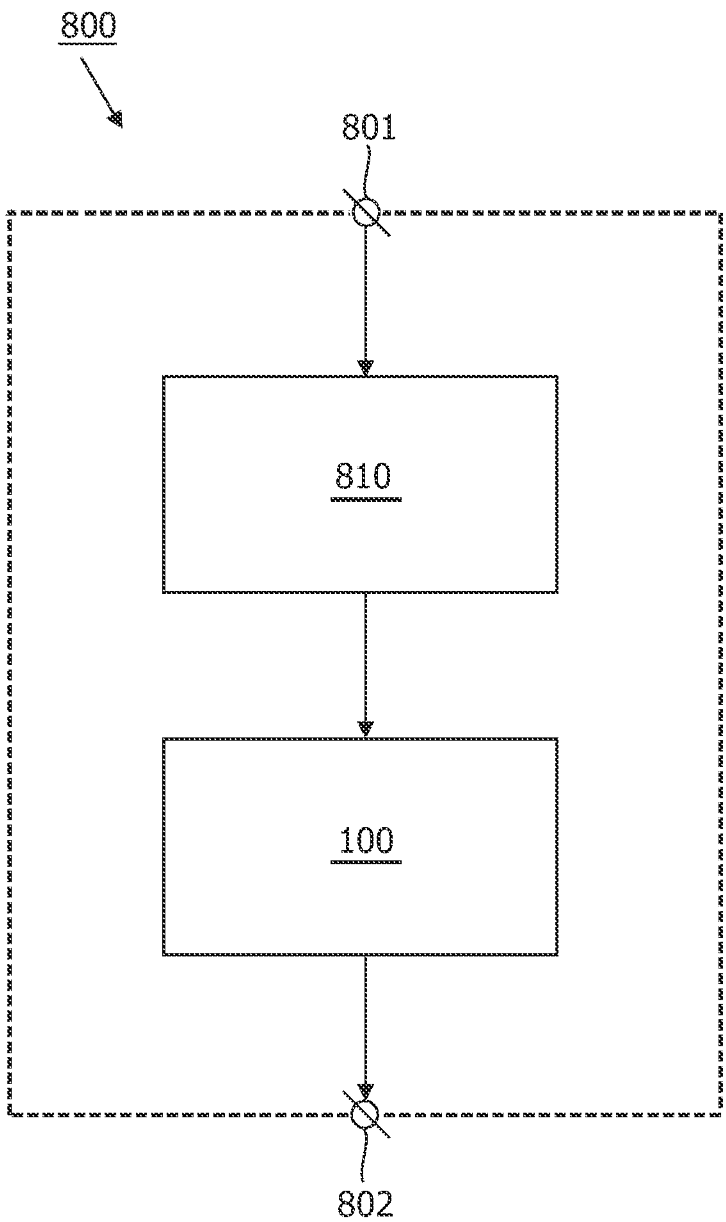

FIG. 8

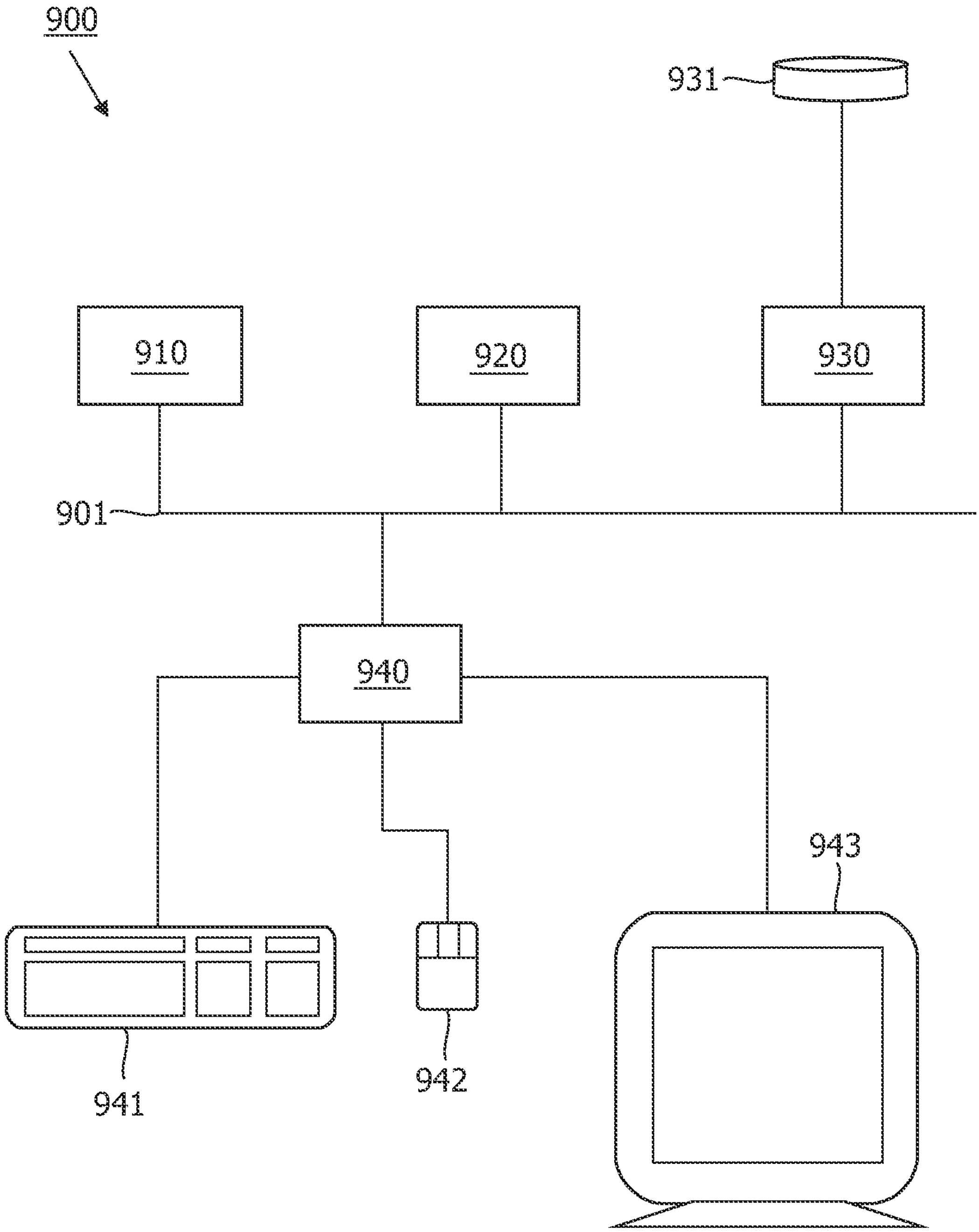

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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- US 20050008209 A1 **[0008]**

Non-patent literature cited in the description

- AHA Scientific Statement: Standardized Myocardial Segmentation and Nomenclature for Tomographic Imaging of the Heart. *Circulation,* 2002, vol. 105, 539-542, http://circ.ahajournals.org/cgi/content/short/105/4/539 **[0007]**

patsnap

专利名称(译)	重新参数化的牛眼图		
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申请号	EP2009775301	申请日	2009-11-27
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	HAUTVAST GUILLAUME L T F		
发明人	HAUTVAST, GUILLAUME, L., T., F.		
IPC分类号	A61B5/00 A61B5/055 G06T11/20 A61B6/00		
CPC分类号	A61B5/055 A61B5/024 A61B5/7425 A61B5/7435 A61B5/7475 A61B6/503 A61B6/507 G06T11/206		
优先权	2008170544 2008-12-03 EP		
其他公开文献	EP2373218A1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于在第一牛眼图中可视化第一图像数据中表示的对象的第一定量分析的结果的系统，特别是用于心脏分析。第一图像数据包括第一多个数据切片，并且系统包括切片单元，用于将第一多个数据切片的数据切片与第一牛眼图的同心环相关联，半径单元用于计算第一牛眼图的同心环半径的长度，以及用于根据与同心环相关联的数据切片计算用于在第一牛眼图的同心环中显示的至少一个值的值单位第一个牛眼图的第一个牛眼图，其中第一个牛眼图的同心环半径的长度是根据与同心环相关的第一个多个数据切片的数据切片的位置来定义的。第一个牛眼图，有尊重对象。第一个牛眼图同心环半径与第一个牛眼图的所述同心环相关的数据切片位置相对于物体的依赖性定义了第一个牛眼图的客观框架，基于对象的几何形状。因此，在第一个牛眼图中可视化的对象的第一次定量分析的结果可以更容易地与在第二个牛眼图中可视化的第二图像数据中表示的相同对象的第二定量分析的结果进行比较，当第二牛眼图的同心环的半径的长度也基于与第二第一牛眼图的所述同心环相关联的数据切片相对于对象的位置来定义。在一个实施例中，每个牛眼图中的对应位置可以由耦合指针指示。另外，进一步指针，每个指针耦合在一个牛眼图中的相应指针可以适于指向第一和第二图像数据的相应数据切片中的相应位置。

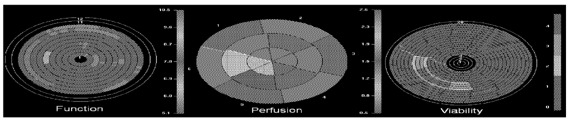

FIG. 1A
PRIOR ART

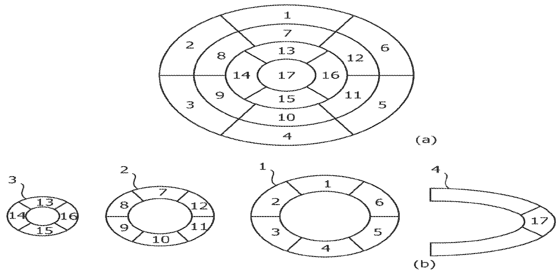

FIG. 1B
PRIOR ART